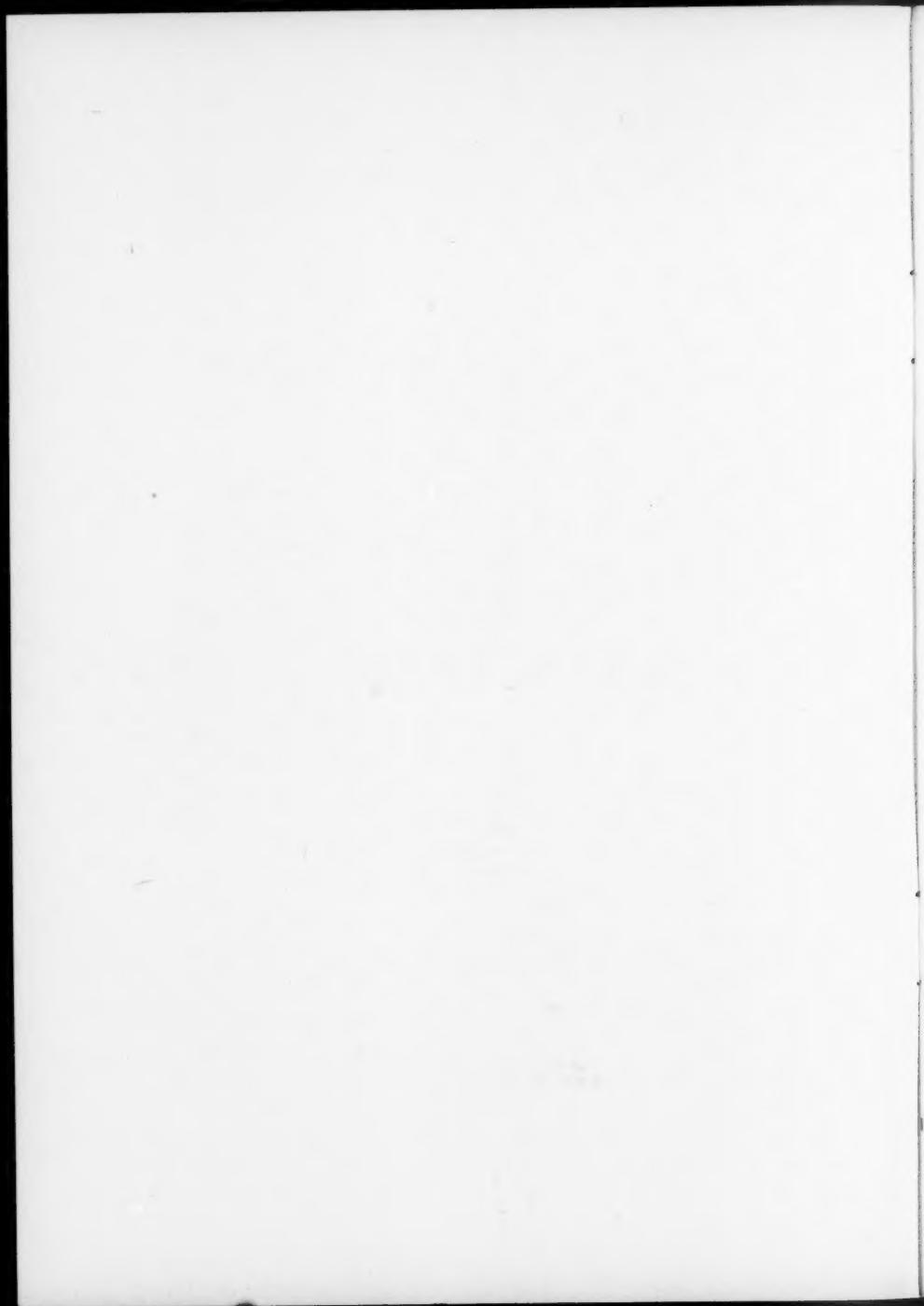


ANNOTATED

INDEX

1971-1972

**Acta
Polytechnica
Scandinavica**



ABSTRACTS OF RECENT MONOGRAPHS

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CHEMISTRY INCLUDING METALLURGY SERIES

Ch 99 (1)

UDC 541.121: 536.7

EAIKSSON, GUNNAR and ROSEK, EAUK: *Thermodynamic studies of high temperature equilibria: I. Calculation of equilibrium compositions and heat balances for the reactions between Cu₂S and air in the temperature range 800 K—1300 K.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 99 (1). Stockholm 1971. Part 1—2. 32 pp. Sw.kr. 10.00. ISBN 91 7082 009 0.

A theoretical investigation was carried out to study the equilibrium reactions occurring when Cu₂S reacts with various amounts of air. Equilibrium and heat calculations were performed in the temperature range 800 K—1300 K at P = 1 atm. The results obtained are summarized in distribution diagrams convenient to visualize the main reactions and to indicate ranges of practical interest.

Ch 99 (2)

UDC 541.121: 536.7

EAIKSSON, GUNNAR: *Thermodynamic studies of high temperature equilibria. II. Calculation of free energy function and heat content function for solid (Cu, S, O)-substances.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 99 (2). Stockholm 1971. Part 1—2. 32 pp. Sw.kr. 10.00. ISBN 91 7082 009 0.

For the solid substances Cu, Cu₂O, CuO, and Cu₂S values of the fundamental thermodynamic functions $(G^\circ - H^\circ_{\text{ref}})/T$ and $(H^\circ - H^\circ_{\text{ref}})$ have been calculated for 6 temperatures from 800 K to 1300 K on the basis of selected thermodynamic data from the literature. In addition, log K_f-values have been calculated using values of $(G^\circ - H^\circ_{\text{ref}})/T$ and $\Delta H^\circ_{\text{ref}}$. To check the reliability of the basic calorimetric data used, values of log K for some important equilibrium reactions were calculated and compared with previous experimental values. These comparisons justified the used calorimetric data with the exception of S°_{ref} for Cu₂S, where it seemed reasonable to propose a new value ($S^\circ_{\text{ref}} = 28.0 \text{ cal} \cdot \text{K}^{-1} \text{ mol}^{-1}$).

Ch 100 (1)

UDC 665.335.9: 66.094.1

PIHL, M. and SCHÖÖN, N.-H.: *Rate factors in liquid phase hydrogenation. I. Kinetics of the hydrogenation of cottonseed oil in the presence of a solid catalyst.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 100 (1). Stockholm 1971. Part 1—5, 120 pp. Sw.kr. 20.00. ISBN 91 7082 011 2.

Rate equations for the catalytic hydrogenation of dienoic acid in glycerides and monoenoic acid in glycerides in cottonseed oil were determined. The hydrogenation was performed using an unsupported nickel catalyst. The rate of hydrogenation of monoenoic acid in glycerides was found to be more dependent on the hydrogen pressure than was the rate of hydrogenation of dienoic acid in glycerides. The difference in reaction order with respect to the hydrogen pressure was 0.5. The reason for this difference was discussed on the basis of a proposed reaction mechanism.

Methods for the determination of external transport resistances and the effect of catalyst poison were established.

Ch 100 (2)

UDC 665.335.9: 66.094.1

LUNDQVIST, L.-E. and SCHÖÖN, N.-H.: *Rate factors in liquid phase hydrogenation. II. Simulation and optimization of the hydrogenation of cottonseed oil.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 100 (2). Stockholm 1971. Part 1—5, 120 pp. Sw.kr. 20.00. ISBN 91 7082 011 2.

On the basis of a recently determined rate equation for the hydrogenation of cottonseed oil in the presence of a commercial nickel catalyst, the weight fraction of C-18 monoenoic acid in glycerides was calculated for batch hydrogenation and continuous hydrogenation at different hydrogen mass transfer resistances, different hydrogen pressures, and different reaction times. The results were compared with those obtained by optimization of the process variables. The calculations showed that the selectivity increased only slightly by optimization of the batch hydrogenation.

The selectivity obtained in continuous hydrogenation performed in a staged reactor is always lower than that obtained in batch hydrogenation. An acceptable selectivity can be attained, however, by proper choice of the process variables. An optimal hydrogen pressure sequence will give only a minor increase in the selectivity compared with the hydrogenation at constant hydrogen pressure and at constant resistance against mass transfer of hydrogen.

Ch 100 (3)

UDC 665.335.9: 66.094.1

HELL, M., LUNDQVIST, L.-E. and SCHÖÖN, N.-H.: *Rate factors in liquid phase hydrogenation. III. Influence of pore diffusion on the hydrogenation of polyunsaturated fatty acid glycerides.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 100 (3). Stockholm 1971. Part 1—5, 120 pp. Sw.kr. 20.00. ISBN 91 7082 011 2.

The influence of the pore diffusion on fat hydrogenation was calculated on the basis of the single pore model. It was shown that the influence of pore diffusion results in a reduced selectivity of the consecutive reactions only at high pressure hydrogens and may account, in part, for the different reaction orders with respect to the hydrogen concentration for the two steps of the consecutive reaction.

Ch 100 (4)

UDC 665.335.9: 66.094.1

ANDERSSON, K., PETERSSON, L. and SCHÖÖN, N.-H.: *Rate factors in liquid phase hydrogenation. IV. Hydrogen mass transfer in hydrogenation of cottonseed oil in a staged reactor at different flow conditions.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 100 (4). Stockholm 1971. Part 1—5, 120 pp. Sw.kr. 20.00. ISBN 91 7082 011 2.

The external resistance against hydrogen mass transfer in cottonseed oil hydrogenation was found to be more dependent on the impeller Reynolds number than on the gas flow number, defined as $(\mu V_d / \sigma)$. The gas-liquid resistance predominates in most cases over the liquid-catalyst resistance and the chemical resistance including the pore transport resistance. Hydrogenation to give the maximum weight fraction of C-18 monoenoic acid in glycerides is possible only at a correctly chosen Reynolds number relative to the gas flow number.

Ch 100 (5)

UDC 665.335.9: 66.094.1

BNOSTRÖM, A., JÄRVHOLM, B. and SCHÖÖN, N.-H.: *Rate factors in liquid phase hydrogenation. V. Influence of non-ideal flow pattern on continuous hydrogenation of cottonseed oil.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 100 (5). Stockholm 1971. Part 1—5, 120 pp. Sw.kr. 20.00. ISBN 91 7082 011 2.

The residence time distribution of the liquid in reactors with different numbers of stages was determined using a radioactive tracer method to give information about the flow situation in continuous hydrogenation of cottonseed oil. The flow pattern in the reactors deviates from ideal flow by the presence of bypass flow.

The residence time distribution function of different mathematical models was fitted to the experimental result. The net formation of C-18 monoenoic acid in glycerides was calculated for different kinds of non-ideal flow at optimized process conditions by means of the mathematical models.

Ch 101

UDC 666.2: 541.65

KARLSSON, KAJ H.: *Absorption of ferric iron in reduced soda-silica glasses containing chalcogenides.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 101. Helsinki 1971. 38 pp. Sw.kr. 10.00.

In an iron doped soda-silica glass melted under reducing conditions oxygen was partly replaced by other chalcogenides and the absorption spectra between 8 and 50 kK were recorded. It has been verified that sulphur and selenium dissolve by replacing non-bridging oxygen ions. The mechanism for tellurium is not known, but it is suggested that it is at least partly oxidized and occupies cation vacancies. The coordination of the ferric ion surrounded by oxygen is found to be mainly tetrahedral and no evidence is found that this is not the case even in an environment of sulphide and selenide. The ligand field splitting Δ of the FeO_4^{4-} complex is -6.35 kK, the Racah parameter B assuming a value of 705 K. The electron transfer absorptions move to lower wavenumbers as the ligand becomes more easily oxidized. Tellurium even undergoes spontaneous oxidation, thus reducing all the ferric iron. Further the different electron transfer absorptions have been identified as due to the transitions $\pi t_1 \rightarrow 3dt_p$, $\sigma t_1 \rightarrow 2dt_2$ and $\pi e \rightarrow 3dt_p$, when going towards higher wavenumbers. The optical electronegativities of the ligands were found to be O^{2-} 3.5, S^{2-} 2.9 and Se^{2-} 2.8.

Ch 102

UDC 541.123.21

AHMAD, SYED I. and FRIBERG, STIG: *Phase equilibria and foam stability in solutions of cationic surfactants*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 102. Stockholm 1971. 14 pp. Sw.kr. 10.00. ISBN 91 7082 010 4.

The possibility to relate foaming properties of solutions to different association conditions of surface active substance has been investigated on a few model systems. The results have shown that foaming with an oil soluble surface active substance in nonpolar solvents can only be achieved when a liquid crystalline phase also is present. Present water has to be dispersed as a W/O emulsion in the nonpolar solution; in other case no foam can be obtained.

Aqueous solutions give rise to foam without the presence of a liquid crystalline phase but such a phase increases the stability of the foam. Hexanol being used as anti foaming agent gives no foam, when combined with a liquid crystalline phase containing water, hexanol and a water soluble surface active substance.

Ch 103

UDC 669.386: 669.146.9: 621.793.2

BERGH, SIGGE: *Surface diffusion of copper on α -iron*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 103. Stockholm 1971. 32 pp. Sw.kr. 10.00.

The present investigation is dealing with a new method of surface diffusion determination. The inter-diffusion of copper in iron is studied in a direct way by measuring a clearly defined mass of copper that under the influence of an equally well defined driving force is transferred by surface diffusion on an iron surface.

The work is performed on a micro scale with specimens weighing less than 1/10 of a milligram being studied. The diffusion process is followed by the aid of microprobe and X-ray fluorescence analyses.

The results differ appreciably from data obtained with conventional mass transfer techniques. Thus an activation energy Q_a of about 25000 cal/mole is found as against more than the double. The remarkably high Arrhenius frequency factor often obtained in surface energy based determinations is not found with the new technique.

The new method has a limited applicability as it is based on the specific chemical and physical properties of a special metal system.

Ch 104

UDC 669.3.017: 548.4: 620.178.3

KETTUNEN, P. O. and KOCKS, U. F.: *Fatigue studies as a statistical work — hardening phenomenon*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 104. Helsinki 1971. 23 pp. Sw.kr. 10.00.

Fatigue is explained on the basis of work-hardening using the ideas of the Statistical Theory of Slip. Work-hardening in copper single crystals was studied under prescribed stress as well as strain amplitudes. A conclusion is drawn that cyclic deformation can be divided into two regions: one in which straining is controlled by "cyclic hardening", i.e. by the entire history from the beginning of cycling; the other in which straining is controlled by the "instantaneous" work-hardening occurring during the half-cycle in question. An eventual fracture seems to require that the yield strength during cycling reaches the value of the dividing stress amplitude between the two regions. At the two prescribing methods, this becomes possible at different applied stress amplitudes, which factum then reflects itself also to the corresponding $S-N$ curves. The existence of an endurance limit, and the likelihood of crack initiation from the surface are explained on this basis. Finally, a competitive equation for the Coffin-Manson law is suggested.

Ch 105

UDC 66.071:519.2
661.53.097

URONEN, PAAVO: *Modelling and simulation of catalytic autothermic gas reactors.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 105, Helsinki 1971, 67 pp. Sw.kr. 10.00.

General methods for deriving static and dynamic mathematical models for autothermic catalytic gas reactors are studied in one-dimensional case. The one-dimensional approach neglects all diffusional effects in axial and radial directions. Both tubular and multitubed reactors are investigated. The effect of diffusion effects on the models is also briefly discussed. The solution methods for static models are studied in detail. The use of finite difference approximation in the solution of dynamic models is briefly discussed. The general methods are then applied to an industrial multitubed type ammonia reactor. First the static model is solved and the behaviour of the reactor when changing various variables is digitally simulated with a computer. Based on the results of the simulation study the static optimization of the reactor is discussed. For the dynamic model a simplified simulation study is made by using the finite difference approximation.

Ch 106

UDC 541.183: 661.183.2

EKEDAHL, ERIK: *A mathematical model for sorption hysteresis. II. Sorption experiments with water vapor on activated carbon.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 106. Stockholm 1971. 37 pp. Sw.kr. 10.00. ISBN 91 7082 014 7.

The sorption and desorption branches of the isotherm for water on an activated carbon have been determined together with a number of scanning curves. The mathematical "SAD" model was applied to the experimental data and thus a surface load function $s(a,d)$ and a lag curve $D_L(a)$ were calculated. It was found that $s(a,d)$ could be treated as a function of a (the relative water vapor pressure on adsorption) alone and that $s(a,d)$ increased from a negative value to positive values when a was increased. Taking "bottle" pores as a model this could be explained by sorption on inner walls at low a values and sorption on menisci at higher a values. Filling and emptying of the inner volumes of the pores were expected to take place in the whole a range. From the position of the lag curve one might expect the pore system to contain pores with narrow throats and wide bodies such as bottle pores and trough-shaped pores.

Ch 107

UDC 546.65/.66:543.423.8

RATINEN, H.: *X-ray excited optical fluorescence of nine rare earth ions in Y_2O_3 , Gd_2O_3 , and La_2O_3 .* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 107. Helsinki 1971. 19 pp. Sw.kr. 10.00.

The spectra from Pr, Sm, Eu, Gd, Tb, Dy, Ho, Er, and Tm in Y_2O_3 , Gd_2O_3 , and La_2O_3 have been measured by X-ray excitation at 100 and 300 K. From these spectra a suitable line for each lanthanide was selected for the intensity comparison. The decrease of some lines from doped Y_2O_3 was followed as a function of time. The delayed excitation of activator ions and broad emission bands due to color centers has been studied by thermoluminescence. The possibility of using X-ray excitation for laser has been discussed briefly.

Ch 108

UDC 676.024.2:519.2.004.14

JÄRVELÄINEN, MARTTI: *A theoretical study of adsorption and axial dispersion in filter cake washing.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 108. Helsinki 1971. 28 pp. Sw.kr. 10.00.

A problem of filter cake washing assuming a geometrical model of the pore spaces, in which axial dispersion occurs in the flow channels, molecular diffusion in the cross channels and adsorption takes place in both channels, is solved by deriving the differential equations and the auxiliary conditions corresponding to the geometrical model. The mathematical problem is solved using the Laplace transform and a method for its numerical inversion that utilizes positive values of the transform variable. The results are presented both numerically with four significant figures and graphically.

Ch 109

UDC 539.4.016.3:669.14
669.15'28'26

SALONEN, L.: *Die Eigenspannungen in den aufgekohlten Schichten bei einem unlegierten und einem Mo-Cr-legierten Einsatzstahl nach verschiedenen Wärmebehandlungen.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 109. Helsinki 1972. 28 pp. Fmk 8.00. ISBN 951-666-006-1.

Proben mit den Abmessungen $7 \times 7 \times 75$ mm, $13 \times 13 \times 100$ mm, $24 \times 24 \times 125$ mm und $45 \times 45 \times 175$ mm wurden in endotherm erzeugtem Aufkohlungsgas aufgekohlt und auf verschiedene Weisen wärmebehandelt. Es wurden die Härte-Tiefe-Kurve und der Eigenspannungsverlauf der Proben bestimmt. Solche Wärmebehandlungsvariablen wie Art der Abschreckung, Einsatztiefe und Probengröße haben keinen merklichen Einfluss auf den Eigenspannungsverlauf des legierten Stahls 20MoCr4. Die Härtbarkeit dagegen hat einen bedeutenden Einfluss. In einer perlitischen Probe liegt das Druckeigenspannungmaximum hart am Rand, aber mit zunehmendem Martensiteanteil vermindert sich die Druckeigenspannung am Rand und die maximale Druckeigenspannung verschiebt sich zu dem Randabstand, wo der C-Gehalt 0,6 % ist.

Ch 110

UDC 662.75.022.313:547.26

HYTÖNEN, O. and KURKI-SUONIO, I.: *On the water tolerance of certain liquid fuel-alcohol mixtures.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 110. Helsinki 1972. 12 pp. Fmk 8.00. ISBN 951-666-015-0.

The scope of this work is to investigate the variation of the water tolerance of one gasoline type and one gas oil type with regard to ethyl- or iso-propyl alcohol addition and the temperature. The experimental method used and results are presented. The main findings are: [in strong mixtures the iso-propyl alcohol yields higher water tolerance for gasolines than ethyl alcohol especially in low temperatures. In the practical range below 10 % this difference is smaller, practically meaningless and certainly smaller than generally believed. In gas oil the iso-propyl alcohol is the only constituent that produces a reasonable water tolerance. For water removal in practical systems only absolute alcohol should be used.

CIVIL ENGINEERING AND BUILDING CONSTRUCTION SERIES

Ci 68

UDC 624.074

MØLLMANN, H.: *Analysis of hanging roofs using the displacement method.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 68, Copenhagen 1971, 52 pp. Sw.kr. 10.00.

The paper contains a derivation of the general displacement method for non-linear elastic structures, full account being taken of the effects of finite displacements. Stiffness matrices are also derived for various types of structural elements. The general theory is then used for the analysis of hanging roof structures. Plane prestressed cable structures (cable trusses) and cable nets (including boundary arches) are studied. A number of numerical examples are solved, and a set of simple approximate formulae for cable trusses are presented.

Ci 69

UDC 624.072.1: 539.382

SALONEN, EERO-MATTI: *A framework method for stretched plates.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 69. Helsinki 1971. 25 pp. Sw.kr. 10.00.

A physical triangular plane stress finite element is derived, composed of three bars situated along the sides of the element. The bars have suitable values of extensional and bending stiffnesses, and are rigidly connected to each other at the three nodes of the element. The displacement parameters at the nodes are the two translational components and the mean rotation of the plate. The element is generally valid only when Poisson's ratio is zero.
By the merging of elements of these kinds a substitute structure is obtained for a stretched plate which can be analysed by a standard plane framework program.

The suitable properties of the bars of the element are found by comparison of the strain energy of the element with that of the plate.

Some examples are analysed by application of the element derived. The theory is limited to linear elasticity for isotropic materials that obey Hooke's law.

Ci 70

UDC 624.012.45
624.072.1

NIELSEN, M. P.: *On the strength of reinforced concrete discs.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 70. Copenhagen 1971, 261 pp. Sw.kr. 30.00.

The paper is concerned with an investigation of the possibilities of utilizing the theory of perfectly plastic materials in the calculation of reinforced concrete discs. The purpose has been mainly to study, theoretically and experimentally, the foundation of a rational theory.

Yield conditions and formulas for the necessary reinforcement required to carry given stresses are derived. The yield conditions are used as a basis of a mathematical theory of plasticity for discs. Several exact solutions are given. Furthermore, some simple statically admissible solutions are derived for rectangular discs with conditions of support and loading frequently occurring in practice.

Finally the tests are treated and compared to theory.

Ci 71

UDC 624.074.4:539.4

KAILA, MARTTI M.: *On the state of stress and displacement of certain shells of translation.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 71. Helsinki 1972. 83 pp. Fmk 8.00. ISBN 951-666-001-0.

The goal of the investigation is to produce relevant information about structures consisting of alternatingly elliptic and hyperbolic paraboloidal shells with a rectangular planform; the individual shells are assumed to be joined together smoothly, without intermediate supporting members. The number of shells, contained in the structures, is fixed at three. All shells are assumed to be shallow, thin, homogeneous, and to obey Hooke's law.

The question, whether the structures under consideration are able to carry transversal load, is studied by deriving formal solutions both according to the membrane theory and according to the bending theory, and by examining the character and the meaningfulness of the solutions.

It is concluded that the structures under consideration are able to carry transversal loads. In the case of some singular configurations the bending resistance of the structures should not be very small.

Ci 72

UDC 539.32: 624.074.5

BUCHHOLDT, H. A.: *The Newton-Raphson approach to skeletal assemblies having significant displacements.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 72. Trondheim 1971. 24 pp. Sw.kr. 10.00.

This paper shows how the analysis of a highly non-linear assembly such as a cable structure can be analysed by minimization of the total potential energy in a number of steps each in the Newton-Raphson direction. For cases which diverge or converge towards a "false minimum", it is shown how the above method can be stabilized.

Ci 73

UDC 624.073.1

FURNES, OLAV: *Rectangular plates with linear variation of thickness.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 73. Trondheim 1971. 27 pp. Sw.kr. 10.00.

The paper describes a method for analyzing elastic, rectangular plates, the thickness of which varies linearly in one direction (the y-direction), and is constant in the other direction (the x-direction), see fig. 1. The discussion is confined to types of plates having simple supports at the edges of constant x, and arbitrary edge conditions at the edges of constant y.

HARTIKAINEN, JORMA: *On the distribution and direction of contact pressure under a rigid foundation.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 74. Helsinki 1972. 63 pp. Fmk 8.00. ISBN 951-666-007-X.

The main purpose of the study is to clarify the effect of load magnitude on the contact pressure distribution by the aid of a systematic series of tests. It has been observed previously already that the magnitude of the load exerts a remarkable influence. In addition, the study concerns the effects of foundation depth and of reloading.

At the construction and designing of the experimental foundation endeavours were taken to eliminate those detrimental factors which had been present before. The distribution of the horizontal contact pressure component was also measured. Particular attention was paid to the scattering of results, several identical test loadings of each kind being performed. A computer line printer output was employed to display the result directly in the form of contact pressure maps; this procedure is highly efficient both in view of computer utilization and of the treatment of results.

The experimental results were clearly between the theoretical extreme values. On the basis of earlier tests the possibilities of applying statistical and numerical methods are discussed.

ELECTRICAL ENGINEERING SERIES

EI 25

UDC 621.391

KOHONEN, TEUVO: *A class of randomly organized associative memories.* Acta Polytechnica Scandinavica, Electrical Engineering Series No. 25, Helsinki 1971, 19 pp. Sw.kr. 10.00.

An associative memory that is randomly organized and in which information is stored in spatially distributed form is suggested. The memory consists of a large number of discrete memory elements onto which transformed input signals are superimposed. The mapping used for memorization is linear in data signals but a general class of transformations is defined by which the data are designated by key information. The mapping used for the recall of a particular item of data is linear in the contents of the memory but a general class of transformations is defined by which the memory is excited by key information. The set of output signals is shown to be a linear mixture of memorized items. If a key used during recall has a high correlation with a particular key used for designation of data, the item associated with this key has the highest intensity in this mixture. The memorization-recall transformation is shown to be reconstructive, selective with respect to memorized items, and redundantly encoded. A measure for the noise and selectivity is defined. The use of this memory for pattern classification and sequential retrieval of information, as well as the use of data as key is also discussed.

EI 26

UDC 621.391

HENTINEN, V.: *A channel state feedback communication system.* Acta Polytechnica Scandinavica, Electrical Engineering Series No. 26, Helsinki 1971, 43 pp. Sw.kr. 10.00.

A new feedback scheme for fading channels is described. In this channel state feedback (CSFB) scheme, the instantaneous value of the channel state is observed and the observation is used to control the signal energy transmitted in order to make efficient use of good channel conditions. Fading in the forward channel is assumed to be slow and nonselective to make it possible to measure the channel state accurately and simply, and to communicate this estimate to the transmitter.

Performance of a certain class of CSFB systems is analyzed, assuming perfect channel estimates. It has been shown that the CSFB system is approximately equivalent to a 4-fold diversity system over Rayleigh fading channels. In diversity transmission using CSFB channels the total energy for a given outage probability or error probability decreases monotonically with the number of diversity branches, in contrast to conventional diversity transmission. The exponential bound parameter, R_p , has also been evaluated for certain coded CSFB systems. At low signal-to-noise ratios, the CSFB channel is superior to the nonfading Gaussian channel. The superiority of the CSFB channel increases monotonically with decreasing signal-to-noise ratio. To illustrate possible practical applications, a short discussion is offered concerning the implementation of CSFB systems.

EI 27

UDC 621.375.7

SOMERVUO, P. and SIRKEINEN, Y.: *On the phase stability of parametric amplifiers.* Acta Polytechnica Scandinavica, Electrical Engineering Series No. 27, Helsinki 1971, 24 pp. Sw.kr. 10.00.

The report is a study of the phase behavior of a parametric amplifier when small variations in pumping or varactor biasing occur. Formulas for the phase instability caused by adjacent signals on the amplifier band are also derived. Experimental results obtained in measurements and with the aid of a computer using a more accurate equivalent circuit of the amplifier are also given.

EI 28

UDC 621.372.823

MARIN, LENNART: *Analysis of a slotted circular waveguide*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 28. Stockholm 1971. 23 pp. Sw.kr. 10.00. ISBN 91 7082 025 2.

The effect of a longitudinal slot in a circular waveguide is investigated. The study involves the formulation and solution of two boundary value problems. The first problem concerns a half infinite slot in the waveguide. The solution to this problem is used in solving the second one: a waveguide with a finite rectangular slot. Making use of leaky-wave modes and of the Wiener-Hopf and Galerkin procedures, the analysis leads to two systems of algebraic equations. The solution to these equations gives the tangential component of the electric field on the slot. The result is applied to the determination of the reflection coefficient and the far-field pattern for an incident wave in the TE_m -mode.

EI 29

UDC 621.391

KOHONEN, TEUVO: *Introduction of the principle of virtual images in associative memories*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 29. Helsinki 1971. 15 pp. Sw.kr. 10.00.

A randomly organized system model for action-oriented associative memory is introduced in this report. The output signals of the model depend on present input signals as well as on memory traces formed by earlier input signals. Alternatively, the output signals can be explained in terms of the present excitation on to which virtual images of earlier input signal patterns are superimposed. These virtual images are then defined to represent memorized and recalled information. The recall is named associative because input activity that has a high correlation with a particular earlier input signal pattern will selectively evoke a virtual image that principally represents this memorized pattern in a complete form. The basic principle of virtual images introduced in this report is believed to apply to most neural networks that contain memory. This model tolerates failures and the memory traces in it are stored in distributed form. The selective reconstruction of memorized images is demonstrated by a computer simulation.

EI 30

UDC 538.3:621.3.029.64
621.3.09

VALTONEN, MARTTI: *A new synthesis method for branch-guide directional couplers*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 30. Helsinki 1972. 19 pp. Fmk 8.00. ISBN 951-666-004-5.

A narrow-band equivalent circuit for a two-port network consisting of cascaded unit-length lossless transmission lines and lumped or distributed lossless shunt elements between them is obtained by replacing the shunt elements by imaginary conductances. This type of network model may successfully be used in the design of both symmetrical and asymmetrical branch-guide directional couplers. The theoretical performance of the couplers at low coupling levels is in good agreement with the earlier results. An optimum termination impedance ratio giving the minimum VSWR level for fixed directivity and coupling levels is given.

LINDELL, ISMO: *Wave normal and ray propagation in lossless positive bianisotropic media*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 31. Helsinki 1972. 22 pp. Fmk 8.00. ISBN 951-666-008-8.

Wave normal and ray propagation associated with a propagating electromagnetic discontinuity in lossless positive bianisotropic media are considered. First, conditions for a lossless bianisotropic medium that has a positive definite energy function (lossless positive medium) are derived. Wave normal and ray equations, which are of the fourth degree, are also derived, and the duality of the equations is discussed. Solutions of a special bianisotropic medium are considered. It is proved that for a general lossless positive bianisotropic medium there always exist two characteristic wave normal and ray surfaces. Transformation formulas for the constitutive dyadics of a moving bianisotropic medium are derived. It is proved that if a lossless positive bianisotropic medium is set in uniform motion, the medium is lossless positive if and only if the velocity is smaller than the smallest characteristic ray and wave normal velocities.

MATHEMATICS AND COMPUTER SCIENCE SERIES

Ma 21

UDC 62—50: 517.949.21: 512.8

SINERVO, JYRKI and BLOMBERG, HANS: *Algebraic theory for ordinary linear time-invariant difference systems*. Acta Polytechnica Scandinavica, Mathematics and Computing Machinery Series No. 21. Helsinki 1971. 34 pp. Sw.kr. 10.00.

The aim of this work is that of developing a general algebraic theory for ordinary linear time-invariant difference systems. The fundamental algebraic structures used are those related to infinite bisequences and matrices. A detailed study is made of the relationship between the theory presented, the discrete version of Mikusinski's operational calculus, the \mathcal{Z} -transform (both one-sided and two-sided types) and the discrete Laplace-transform.

Ma 22

UDC 676.1.022.6

JOHNSSON, LENNART: *Mathematical models of the kraft cooking process*. Acta Polytechnica Scandinavica, Mathematics and Computing Machinery Series No. 22. Stockholm 1971. 115 pp. Sw.kr. 20.00. ISBN 91 7082 018 X.

A dynamic model of the continuous kraft cooking process with concurrent flow of chips and liquor is derived. The model also includes a description of counter-current diffusion washers. The dynamic model is simplified to a static model in order to facilitate a check with plant data. A computer program for the solution of the model equations has been written. From data gathered from experimental investigations it is clear that the model applies well to high-yield kraft pulping. Especially interesting is the fact that not only the Kappa number but also the inhomogeneity of the pulp may be predicted. This is possible since the model takes account of the chip thickness distribution and the diffusion properties of the wood. Interesting results are obtained from computations with the model for both design and control purposes.

Ma 23

UDC 311.218

681.326.7: 676.2.052

GERDIN, KRISTER: *On histogram uncertainty for normal, stationary signals with an application to paper machine disturbances*. Acta Polytechnica Scandinavica, Mathematics and Computing Machinery Series No. 23. 62 pp. Sw.kr. 10.00. ISBN 91 7082 013 9.

A method for obtaining the variance of histograms estimated from dependent observations of a normal, stationary process is described. The method is based on the summation of a certain series, involving Hermite polynomials. Numerical calculations can be performed to predetermined accuracy. The method is applied to some signals with rational spectral density function. Variance dependence on measurement parameters is investigated as well as the goodness of the effective bandwidth approximation of the spectral density function. An application to sampling rate determination for measurements on a paper machine is also described.

HALME, AARNE: *Polynomial operators for nonlinear systems analysis*. Acta Polytechnica Scandinavica, Mathematics and Computer Science Series No. 24. Helsinki 1972. 64 pp. Fmk 8.00. ISBN 951-666-002-9.

The concept of polynomial operators is considered and applied to the analysis of nonlinear dynamical systems, especially for purposes of automatic control. The approach is functional analytic, which makes it possible to apply the theory widely to most systems characterized by a polynomial type nonlinearity. The main result is a theorem concerning local invertibility of polynomial operators although also other important algebraic and topological properties are derived. The theorem shows how a local inverse can be constructed by a recursive representation and gives an explicitly determinable validity region for this representation. Applications are presented concerning differential equations with polynomial type generators, generally defined in Banach spaces. The local inverse theorem is used to find the solutions and to investigate stability and controllability properties of these equations. As an example the swing equation of a synchronous machine is considered.

MECHANICAL ENGINEERING SERIES

Me 54

UDC 621.891: 532.516

JACOBSON Bo: *On the lubrication of heavily loaded spherical surfaces considering surface deformations and solidification of the lubricant.* Acta Polytchnica Scandinavica, Mechanical Engineering Series No. 54. Stockholm 1971. 56 pp. Sw.kr. 10.00.

Lubrication of a point contact between two spheres is studied. The viscosity of the oil is assumed to vary with pressure and temperature. The oil is assumed to be solidified above a certain pressure, which is dependent of the temperature. The solidified oil is assumed to have a shear strength independent of pressure and temperature. Continuity conditions for the cavitation boundary, the boundary between liquid oil and solidified oil, and the boundary between sliding and non-sliding solidified oil are given. Numerical calculations of height functions, pressure distributions, and load capacities are made for the isothermal case. An experimental investigation of the oil film thickness in a rolling point contact is carried out. There is good agreement between theory and tests. The shear strength of solidified oil has been experimentally determined.

Me 55

UDC 621.9.025.7:620.178.16

PIETIKÄINEN, JUHA: *The effect of the practical machining parameters on the formation of a tool wear inhibiting layer.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 55, Helsinki 1970, 23 pp. Sw.kr. 10.00.

By turning slightly hypoeutectoid carbon steel forming a wear inhibiting layer on the tool with a sintered insert, a study was made of the effects of depth of cut t , feed s , rake angle, nose radius, sintered insert carbide grade and method of cutting on the maximum speed, v_{xy} , at which the wear inhibiting layer is still formed.

The test results show that v_{xy} decreases as the depth of cut and feed increase; a higher v_{xy} value is obtained with a positive than with a negative rake angle; moving from the lowest cutting speeds to the top speeds, and cutting with the same tool edge gives a higher v_{xy} value than cutting with a new tool edge at each cutting speed; the nose radius has little if any effect on v_{xy} ; when cutting, iron adheres to the clamped insert K20 but not to inserts P10 and P30. It was concluded on the basis of the test results that there is a surface $v_{xy} = v_{xy}(s, t)$ in the $s-t-v$ axes, and the dependencies and significance of this were examined; from the point of view of layer formation poor wetting between chip and tool is good.

Me 56

UDC 621.822.573—762

ANDERSSON, BERT: *On optimum design of hydrodynamic lip seals.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 56. Stockholm 1971. 67 pp. Sw.kr. 10.00.

Hydrodynamic seals for both unidirectional and bidirectional rotation are studied. The shaft is assumed to be ideally circular, and its surface is assumed to be perfectly smooth. The liquid to be sealed is assumed to be Newtonian and incompressible and the viscosity variations within the film are neglected. Sub-atmospheric pressures are also neglected.

The optimum geometries of the seals are determined. Radial load, power loss, and sealing capacity have been calculated.

Tests have been made for sealing capacity and power loss for an optimum unidirectional rotation seal. The agreement between theory and test is quite satisfactory.

Additional tests with real seals, made from synthetic rubber, showed that the power loss is smaller for a hydrodynamic seal than for a conventional seal in accordance with the theory.

Me 57

UDC 539.434: 624.074.4

HELLAN, KÅRE: *Finite creep of closed membranes of revolution*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 57. Trondheim 1971. 20 pp. Sw.kr. 10.00.

The creep of a closed membrane of revolution subject to uniform pressure is investigated. Large deformation incremental theory including a non-linear creep law is applied. A numerical analysis is carried out for initially ellipsoidal shapes and various material parameters, providing deformation patterns and critical times.

Me 58

UDC 621.822.2

LUNDHOLM, GUNNAR: *The axial groove journal bearing considering cavitation and dynamic stability*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 58. Stockholm 1971. 111 pp. Sw.kr. 20.00.

Hydrodynamic lubrication of the journal bearing with one or two axial oil grooves is studied. The grooves are fed with oil under atmospheric pressure. Sub-cavity pressures are neglected and the viscosity is assumed to be constant. The calculations cover variations of the width-to-diameter ratio, relative eccentricity, and the angle between the oil groove and the direction of the load. The locations of the cavitation regions are found by applying boundary conditions which guarantee continuity of oil flow. Routh's stability criterion is used for the investigation of the dynamic stability assuming small oscillations. Load capacity, power loss, oil flow and stability borderlines are given in design charts, from which a bearing with minimum power loss for a given load and with stable running can be designed. Tests have been made for stability borderlines, which show good agreement with the theoretical results.

Me 59(1)

UDC 621.822: 621.89

STRÖMBERG, JAN: *The plane pad bearing of infinite width considering variable viscosity along as well as across the fluid film*. Acta Polytechnica Scandinavica. Mechanical Engineering Series No. 59(1). Stockholm 1971. Part 1 and 2, 122 pp. Sw.kr. 20.00. ISBN 91 7082 015 5

This report gives a theoretical treatment of the plane pad bearing of infinite width considering variable viscosity along as well as across the fluid film. Adiabatic conditions are used with variations in the viscosity due to the temperature and the pressure of the oil.

In two cases the heat transfer to the moving solid is considered showing small deviations from the corresponding adiabatic case. Solutions are given for different pad inclinations, different non-dimensional viscosity-temperature coefficients and different non-dimensional thermal conductivity coefficients of the oil. The result shows that only under certain circumstances the temperature variations across the fluid film are negligible.

With thanks to the author for permission to publish this report.

Me 59(2)

UDC 621.822.2

STRÖMBERG, JAN: *The sector thrust-bearing considering variable viscosity.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 59(2). Stockholm 1971. Part 1 and 2, 122 pp. Sw.kr. 20.00. ISBN 91 7082 015 5

This work gives a theoretical treatment of the sector thrust bearing. It considers the variation of the viscosity due to temperature and pressure in the radial and the circumferential directions.

Calculations are made to give values for bearing design, and are performed on a digital computer and therefore the accuracy is more than enough for technical purpose.

Calculations are made for the whole range of practical design. Charts of load capacity, load location, oil flow, power loss, maximum temperature and relative power loss are given, and in the appendix, tables of the mean temperatures at the inlet and the outlet may be found. It is shown how to choose the optimum number of pads. Optimum here means either minimum total relative power loss or maximum total load. Estimation is made of the change in the bearing quantities if the variation of the viscosity across the oil film is considered.

Me 60

UDC 621.592

GUSTAFSSON, ORWAR: *A theoretical analysis of a new process for liquefaction of gases.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 60. Helsinki 1971. 36 pp. Sw.kr. 10.00.

The new idea in the liquefaction process described consists in the expansion of a gas adiabatically with a minimum of entropy production through a nozzle and the maintaining of the high kinetic energy, obtained at the expansion, through the heat exchanger.

The liquefaction coefficient, the work required per unit mass of gas compressed and the work required per unit mass of gas liquefied are calculated for different values of exit speed, inlet pressure and efficiency of the heat exchanger and for different compressor efficiencies. From these calculations it is clear that the figure of merit for the new process is superior to that of the Linde-process and is for $\epsilon = 0.95$ and $\eta_e = 70\%$ without precooling or dual-pressure system almost as large as for the Claude-process with the same performance parameters. For the new process, however, neither expansion engine nor throttling device are needed but are replaced by a nozzle.

Me 61

UDC 532.526: 532.59

GJEVIK, BJØRN: *Spatially varying finite-amplitude wave trains on falling liquid films.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 61. Trondheim 1971. 16 pp. Sw.kr. 10.00.

In a previous paper the occurrence of steady finite-amplitude waves on falling liquid films has been studied by a long wave expansion technique. This analysis is now extended to include spatially varying wave trains. The solutions presented may correspond to the forced wave trains occurring downstream from a wave generator. Moreover the second order terms in the long wave expansion are reported and their effect on the finite-amplitude wave motion is studied. Numerical results for finite-amplitude waves on thin films of water or alcohol are presented.

Me 62

UDC 621.873.001.24

KREX, HELGE: *Elementary calculation of jibs for mobile cranes*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 62. Copenhagen 1971, 14 pp. Sw.kr. 10.00.

This article describes a simple method of calculation applicable to determination of the principal dimensions of the type of jibs, of lattice or box-type design, used for mobile cranes.

It is assumed that, subject to certain qualifications, the jib can be considered as one single member in compression that, in a vertical plane — the luffing plane — is provided with a hinged support at the foot, whereas it has a fixed support in the plane at right angles thereto — the slewing plane.

The method is applicable to calculative investigation of the ultimate conditions of the jib, taken as a column, lateral deflections arising from transversal forces and external bending moments, and moments in lattice members and the bending stress originating therefrom. In respect of lattice girders, this means that compressive and tensile forces in the chords can be calculated.

The method is applicable to main-jib as well as fly-jib, and also to the effects of the fly-jib on the main-jib.

Me 63

UDC 621.824.539.413

LEINONEN, TATU E.: *Notes on the bending behaviour of slightly curved rotating shafts*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 63. Helsinki 1971. 19 pp. Sw.kr. 10.00.

Many scientists have studied the problem of stability in a rotating shaft by assuming a shaft with zero initial curvature. This paper extends the classical theory by taking a slight curvature of the shaft into account. The slight curvature is approximated by a Fourier series. A theoretical model is developed which illustrates the behaviour of the shaft during rotation. During rotation in the slightly curved shaft bending stresses will appear, which the theoretical model also gives. The present study tests how well the theoretically produced model illustrates these stresses in practice in shafts with shingled-hinged bearings. The theoretical stresses and stresses measured by strain gauges have been found to be in good agreement with each other.

Me 64

UDC 621.867.4

NILSSON, LARS-GUNNAR: *On the vertical screw conveyor for non-cohesive bulk materials*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 64. Stockholm 1971. 96 pp. Sw.kr. 10.00. ISBN 91 7082 016 3.

The behavior of non-cohesive bulk materials is studied in order to find a pressure distribution that can be used for calculation of vertical screw conveyors. A new calculation method for vertical screw conveyors is presented. Regard is paid to the larger fillings that can be obtained in modern conveyors furnished with a special feeding apparatus.

Diagrams containing non-dimensional parameters for calculating efficiency, transport capacity, and axial force on screw are given. The diagrams make it possible to design conveyors with maximum efficiency.

Experiments show good agreement between theory and tests.

Experiments with rotating screw and counter-rotating transport tube show that centrifugal forces are not necessary in order to obtain transport in the well-filled conveyor.

Finally a calculation method is outlined for transporting materials, supposed to have high internal friction.

Me 65

UDC 629.78-531.1

ARHO, RISTO: *A perturbation solution of the deceleration trajectory in ballistic re-entry.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 65. Helsinki 1971. 19 pp. Sw.kr. 10.00.

A perturbation method is developed to solve the deceleration trajectory of ballistic re-entry in a moving atmosphere.

Me 66

UDC 629.762.2-531.112

ARHO, RISTO: *Free flight and re-entry of a missile with a high ballistic coefficient.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 66. Helsinki 1972. 24 pp. Fmk 8.00. ISBN 951-666-000-2.

Taking the inertial position and velocity given at an epoch of time as the initial conditions the free flight and the re-entry trajectories of a missile with a high ballistic coefficient ($C_D A/m \approx 10^{-4} \text{ m}^2/\text{kg}$) are determined. A Fortran-program is developed to find the impact point with a maximum error of $\approx 0.3 \text{ km}$.

Me 67

UDC 621.852.13.031:539.375

GERBERT, B.G.: *Force and slip behaviour in V-belt drives.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 67. Helsinki 1972. 101 pp. 16.00 Fmk. ISBN 951-666-009-6.

A theory for V-belt drives is proposed. The theory considers the radial and circumferential motion of the belt and is based on transverse and longitudinal deformation of the belt. A change in the radius of curvature in the entrance and exit regions is treated.

The theory makes it possible to explain the difference in action between a driven pulley and a driving one. Diagrams are given for force variation, belt motion, power loss, axial force, and slip.

Belt properties, the difference in action between a driven and a driving pulley, the slip factor and the power loss have been determined experimentally. Belt force variation in a drive with locked centre distance has been investigated both theoretically and experimentally. The agreement between theory and experiment is satisfactory.

Me 68

UDC 629.734.07:519.3
797.55

ARHO, RISTO: *Optimal dolphin soaring as a variational problem*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 68. Helsinki 1972. 17 pp. Fmk 8.00. ISBN 951-666-016-9.

The problem of minimum flight time in dynamic soaring is solved by the application of calculus of variations. The technique of »dolphin motion» is demonstrated by two examples.

PHYSICS INCLUDING NUCLEONICS SERIES

Ph 74

UDC 536.71

FAGERHOLM, NILS-ERIK: *On the determination of thermodynamic relationships in steady flow processes.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 74, Helsinki 1971, 35 pp. Sw.kr. 10.00.

A thermodynamic equation of general validity is derived in the form $dh = \varsigma d(pv)$, where $\varsigma = 1/A + B/\eta$. A and B are parameters, which depend on the fluid properties and η is a parameter, which specifies the character of the process. Since the equation refers to a process it is called a process equation. General expressions for the determination of the parameters A and B are given. The parameter $\eta = dh/dpd = dh/dh$, expresses the change in the thermodynamic state in the h,s -plane and takes into account the entropy changes, both reversible and irreversible, in a process. Proceeding from the process equation it is shown, that relationships between thermodynamic variables can be obtained in an explicit form. p,v,T -relations are given for a general process and for some constant-parameter processes: the isentropic, isobaric, isochoric, isothermal and isenthalpic process. Formulae for calculation of enthalpy, entropy, internal energy and exergy changes are derived. A numerical example showing the use of the obtained formulae is given. Fluid parameter values A , B , and J , (dimensionless Joule-Thomson-coefficient) for water vapour are presented by diagrams. The use of the process equation in thermodynamical systems analysis is outlined in an application to one-dimensional gas dynamics.

Ph 75

UDC 539.67: 620.1.084

KLEEMOLA, H. J., PEKONEN, S. T. and SULONEN, M. S.: *Equipment for the continuous recording of internal friction at low frequencies and constant amplitude.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 75, Helsinki 1971, 15 pp. Sw.kr. 10.00.

A devise for the continuous measurement of internal friction at low frequencies, which is based upon the inverted torsion pendulum, is described. Continuous oscillation of the pendulum is maintained by a coil which is in the field of a permanent magnet. In the field there is also another coil, the induced voltage of which is amplified, controlled and fed back to the former in such a way that the amplitude of oscillation remains constant in the strain amplitude region 10^{-4} – 10^{-4} .

The pendulum oscillates at the resonance frequency, and thus the possible frequency range in the equipment is about 1–20 c/s depending on the dimensions of the specimen and the inertia member used. The specimen under test can be plastically deformed *in situ* at any testing temperature. The pendulum is situated in a chamber which can be evacuated if vacuum conditions are needed.

Ph 76

UDC 621.317.412: 621.3.084

KELHÄ, V. and NIINIKOSKI, T.: *Susceptibility measuring device for the following of a martensitic transformation during tensile testing.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 76, Helsinki 1971, 16 pp. Sw.kr. 10.00.

This paper presents a method by which it is possible to follow the martensitic transformation occurring in a copper-rich copper-iron alloy during tensile testing using the continuous measurement of magnetic susceptibility. The device consists of two identical coil sets, which are used in an a.c. bridge circuit, between which is inserted a cylindrical bar specimen. The signal of the bridge has been calculated as a function of the susceptibility and the conductivity of the specimen. The accuracy and the reproducibility of the results is 5 %.

Ph 77

UDC 550.38

BOSTRÖM, ROLF: *The magnetic field of three-dimensional magnetospheric model current systems and currents induced in the ground.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 77. Stockholm 1971. 28 pp. Sw.kr. 10.00.

High-latitude magnetic disturbances are caused by currents flowing in the auroral ionosphere and along the geomagnetic field lines connecting the ionospheric part of the current system with currents in the outer magnetosphere. An account is given of methods to study the magnetic disturbances of model current systems including field-aligned currents. Direct integration, spherical harmonic expansion, and effects of currents induced in the ground are discussed and some examples given.

Ph 78

UDC 538.3

621.3.011.21: 53.001.11

LINDELL, ISMO V.: *On the formulation of a class of electromagnetic field problems in terms of vector admittance and impedance functions.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 78. Helsinki 1971. 60 pp. Sw.kr. 10.00.

Vector admittance and impedance concepts for electromagnetic fields are defined and a theory for them is evaluated. The main theory is restricted to fields with the electric or the magnetic field noncircularly polarized and with the condition $E \cdot H = 0$ satisfied almost everywhere in the region considered. The vector admittance and impedance quantities are seen to obey nonlinear partial differential equations of first order. Boundary conditions for these quantities are also discussed.

Ph 79

UDC 539.122.04: 621.039.564.2

519.2.004.14

BÄRS, BRUNO: *On the influence and use of gamma radiation in reactor noise measurements.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 79. Helsinki 1971. 33 pp. Sw.kr. 10.00.

The influence and use of gamma radiation in reactor noise measurements is studied based on a space- and energy-independent reactor and detector model. The approach is based on the forward Kolmogorov equation and is carried out in a consistent and unified way. The influence of the correlated and noncorrelated photon radiation and the influence of a large number of reactor and detector characteristics on the variance of the cumulative number of signal units, on correlation functions and on power spectra associated with the detector signals are explicitly given. The detection model includes the main detector types such as pulse detectors and compensated ionization chambers where the detection is based on absorption, recoil or fission.

The presented model can be used for interpretation of noise measurements in gamma fields. It also reveals that the use of gamma sensitive or combined neutron and gamma sensitive detectors in principle makes it possible to extract additional information from noise measurements compared to measurements with purely neutron sensitive detectors.

Ph 80

UDC 537.311.33:548.71:546.23

KRUSIUS, PETER and SUOSARA, EERO: *Tight binding core states of trigonal selenium*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 80, Helsinki 1971, 36 pp. Sw.kr. 10.00.

Core states for crystal atoms of trigonal selenium are constructed by a central field approximation of the crystal potential, which is determined by a set of atomic eigenstates in the tight binding approximation. The influence of the central field approximation on the core states is estimated. The core states are used to construct Bloch wave functions and the choice of these functions with respect to the OPW method is discussed.

Ph 81

UDC 621.59:536.711
621.576

GYLLING, R.G.: *Construction and operation of a nuclear refrigeration cryostat*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 81, Helsinki 1971, 66 pp. Sw.kr. 10.00.

A cryostat has been constructed, in which a powerful dilution refrigerator and a superconducting solenoid wound with filamentary NbTi wire have been combined to produce the initial conditions $T_1 = 16$ mK and $B_1 = 5$ Vs/m² for nuclear demagnetization experiments. A large specimen containing 12 moles of copper was demagnetized and the external heat leak was reduced to 10^{-9} W/mole. The thermometry consisted of a pulsed NMR thermometer with which the temperature of copper nuclei at a distance from the demagnetization region could be measured. This thermometer was calibrated against a ⁵⁴Mn in nickel nuclear orientation thermometer, and the linearity of the NMR thermometer was checked by measurements of the spin-lattice relaxation time of copper down to a temperature of 1 mK. The uncertainty in the reported temperatures has thus been reduced to 5 %. The minimum temperature recorded in a final magnetic induction of 0.036 Vs/m² was 0.54 mK. This was found to correspond to a minimum electron temperature of 0.37 mK in the demagnetization region, significantly lower than ever before achieved. Temperatures below 2 mK were maintained for 12 hours, demonstrating the feasibility of this apparatus for research in this temperature region, which cannot be reached by any other known method of refrigeration.

Ph 82

UDC 546.24-386:539.216.2-537.311.33
539.213-537.311.33

SUNTOLA, TUOMO: *Electrical conduction and switching in chalcogenide thin films*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 82, Helsinki 1971. 41 pp. Sw.kr. 10.00.

The conduction mechanism and switching effect in chalcogenide thin films have been studied using vacuum evaporated sandwich samples with $\text{Te}_x\text{Ge}_{1-x}$ and $\text{Te}_{50}\text{As}_{30}\text{Ge}_{10}\text{Si}_{10}$ composition. The main experimental work done on the conduction mechanism consists of studies on high field effects. The Poole-Frenkel emission and tunneling from traps to conduction and valence bands have been analyzed. The switching effect has been explained as an electrothermal instability. The distributions of temperature, electric field and current density have been calculated taking into account the field dependence of the current. According to the calculations the characteristics of a thermal runaway are modified in thin samples by a saturation of the current density and an electric breakdown near the contacts, due to a high electric field caused by the temperature gradients. When there is no filament formation the influence of self-heating appears in the current versus voltage characteristics as a region of negative differential resistance. In this case the temperature gradient in the radial direction is small and negligible in a vertical direction in relation to the layer. Due to the high filament temperature in the conducting state the operation reliability is poor and the number of switching cycles is limited. Therefore, one cannot expect to make wide technical use of chalcogenide thin film switches.

Ph 83

UDC 539.31·517.948·624.04

JUMPPANEN, PAULI: *On nonlinear viscoelasticity analysis with application to experiments.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 83. Helsinki 1971. 48 pp. Sw.kr. 10.00.

In this study, constitutive equations of functional form which retain terms up to the third order are considered with respect to nonlinear viscoelastic materials. Special forms of kernel functions are presented for processes of long-duration, and an investigation is made into the evaluation of material constants by the application of stress-relaxation curves of the material.

The numerical values of material constants are solved for a polyvinyl-chloride and for a plexiglass. These values are applied to analyses of a stretched bar and of two bent beams made of the respective materials. Some experiments have been made to test the validity of the results. The agreement between theory and experiment is satisfactory. In conclusion, a study is made of a cylindrical bar in torsion without numerical applications.

Ph 84

UDC 537.533.35·621.386

PESSA, V.M.: *An electron gun for Auger and ultrasoft X-ray apparatus.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 84. Helsinki 1971. 16 pp. Sw.kr. 10.00.

A small size electron gun with four electrodes has been constructed especially for Auger and ultrasoft X-ray instruments. The gun produces a roughly parallel electron beam with high intensity at constant potentials between 0.5 and 6 keV. The beam has in this energy range an intense core of about 1 mm in diameter. An optical bench is used as a framework in the construction of the gun. All critical lens parameters as well as constructional details are given.

The potential of the third electrode giving the maximum beam current is found to depend linearly on the beam energy, which makes operation of the gun convenient. The two other electrodes are maintained at constant voltages.

Ph 85

UDC 621.039.55·621.3.062.9
546.19'24'28'289

TAINAINEN, O.J.A. and SUNTOLA, T.: *Reactor irradiation of chalcogenide threshold switches.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 85. Helsinki 1971. 16 pp. Sw.kr. 10.00.

Chalcogenide threshold switches of Te-As-Ge-Si-type were irradiated in a reactor up to a fast neutron fluence of 2.4×10^{17} n/cm². The radiation resistance of the devices was studied by measuring the radiation induced changes in the small signal conductivity and high field currents of the sample material. The activation energies of small signal conductivity and high field currents were found to decrease due to irradiation and in some cases a high radiation induced increase in the off state conductance was observed.

Ph 86

UDC 537.311.33:548.71:546.23

V. BOEHM, J., KRUSIUS, P. and SUOSARA, E.: *OPW energy bands of trigonal selenium*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 86. Helsinki 1972. 30 pp. Fmk 8.00. ISBN 951-666-003-7.

The non-relativistic electronic energy band structure of trigonal selenium was determined using the symmetrized OPW method and a constructed crystal potential. The results obtained are most similar to the pseudopotential bands of PICARD and HULIN. The overall band structure agrees with experiment, but the energy gap obtained is not satisfactory.

Ph 87

UDC 539.125.523.43

SILVENNOINEN, PEKKA: *Eigenfunctionals of the one-dimensional transport operator in modal approximations*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 87. Helsinki 1972. 18 pp. Fmk 8.00. ISBN 951-666-005-3.

Eigendistributions of the linear Boltzmann operator are constructed in modal approximations. The formalism is a generalization of the conventional multigroup theory. Eigendistributions consist of the principal value functionals and the derivatives of the δ -distribution. The customary proof of completeness of the normal modes is not applicable here. In a simple case of symmetric scattering an auxiliary set of functionals is shown to be complete when augmented with the ordinary discrete eigenfunctions.

Ph 88

UDC 539.125.162.2.03:539.125.523.348

KALLI, HEIKKI: *Monte Carlo calculations of a hydrogen cold neutron source*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 88. Helsinki 1972. 28 pp. Fmk 8.00. ISBN 951-666-010-X.

This paper discusses the results of Monte Carlo calculations of a hydrogen cold neutron source in a tangential beam tube configuration. In the calculations the shape of the cold neutron source was cylindrical with half-spherical ends and its diameter fixed. Its length was optimized. The calculations were performed for hydrogen at two different temperatures: (1) for gaseous hydrogen at 35 K by varying the source length, the pressure and the relative ortho/para abundance, (2) for liquid hydrogen at 20.4 K by varying the source length and the relative ortho/para abundance.

In both cases the optimal length was about 40 cm and hence the cold neutron source obtained differed radically from the previous cold neutron sources. Contradictory to some earlier results, parahydrogen was found to be a better cold neutron source material than orthohydrogen.

Ph 89

UDC 539.125.523.348

KALLI, HEIKKI: *On the variance reduction techniques in Monte Carlo solutions of neutron transport problems.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 89. Helsinki 1972. 24 pp. Fmk 8.00. ISBN 951-666-011-8.

The Monte Carlo solution of stationary neutron transport problems is discussed. Recent work on variance reduction is reviewed. The variance reduction techniques are divided into two principal classes. The techniques in the first class are based on non-analog random walk processes designed to reduce the variance of an estimator for single histories. The techniques in the second class are designed to reduce the variance for sets of unindepedent histories. The theory of non-analog random walk process techniques is applied to the estimation of neutron flux at a point. A numerical test is performed.

Ph 90

UDC 621.039.566.8 62-50

SALO, SEppo: *Optimal xenon shutdowns for boron controlled reactors.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 90. Helsinki 1972. 20 pp. Fmk 8.00. ISBN 951-666-012-6.

This paper introduces a new class of optimal xenon shutdown problems. Pontryagin's optimum theory is applied to the problem of determining a flux shutdown program that limits xenon poisoning with minimum cost in a reactor, where the amount of excess reactivity depends on the amount of boron present in the core of the reactor. Solutions are found for both the problem of minimum time and the problem of minimum flux time. Both solutions appear to be similar to those in rod controlled reactors.

Ph 91

UDC 539.125.523.4

RAJAMÄKI, MARKKU: *Energy-dependent neutron transport in two adjacent media.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 91. Helsinki 1972. 28 pp. Fmk 8.00. ISBN 951-666-013-4.

The singular eigenmode technique is applied to energy-dependent two-media problems using degenerate expansions as the scattering kernels. Complete procedure for determination of the expansion coefficients of the eigenmodes is given. The exact treatment of the energy-dependent total cross sections allows one to obtain Fredholm equations which are more appropriate to computation than those in the corresponding multi-group scheme. After an approximation of the scattering kernels, the developed method is exact, and it can be considered useful from the viewpoint of computation.

JAUHO, P., VUORI, S.: *Ionization of the atmosphere and the attenuation of radar waves after a nuclear explosion*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 92. Helsinki 1972. 26 pp. Fmk 8.00. ISBN 951-666-014-2.

A simple model for the ionization of the atmosphere is presented. It is based on experimental data and results of Monte Carlo calculations found in literature. The following ionization sources are taken into consideration: Prompt and delayed fission gammas and neutrons, fusion neutrons, and gammas from inelastic scattering or capture of neutrons. Electron densities are calculated using simplified ion balance equations. Electron density contours at 7 explosion altitudes 1 and 10 seconds after the detonation are shown. Corresponding to these cases the attenuation of radar waves (300 MHz) is also presented. According to our results considerable attenuation occurs only during a few seconds. This differs from the information given in open literature. The possible reason is incorrect values of experimental constants or neglected sources of ionization.

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